Frequently asked questions about eucalypts and water use

Sustainability
FAQs

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Do eucalypts use more water than pines?

Statements are often made that *Eucalyptus* trees use more water than *Pinus* trees. Recent investigation by members of the South African Water Research Commission (WRC) has pointed out a lack of scientific evidence supporting quoted differences in water use between eucalypt and pine species[1]. Recent research also showed that water use by trees could be more affected by soil characteristics (soil depth), environment (slope and landscape position) and climate than by the genus planted. Research results from various studies comparing water use of pines to that of eucalypts varies greatly and does not consistently show that one genus uses more water than the other[2,3]. There are a number of factors that could play a role here.

A common mistake in assessing the differences in water use between pines and eucalypts occurs when trees are measured at a common age and not at a common crown development (leaf area) stage. The pattern of water use over the stand-development period is similar to that of nutrient use and follows the growth-curve pattern. It increases from planting until it reaches a peak at the time of canopy closure and thereafter decreases over time. It is inaccurate to compare the water use over just the first five years of the rotations. Thus, water use over two *Eucalyptus* rotations of 10 years should be compared to that of a 20-year pine rotation. If the comparisons are made over a longer time-span, differences in water use between *Pinus* and *Eucalyptus* are not statistically significant. It has even been demonstrated in South Africa that the water use of very old plantations returns to levels of water use in the natural vegetation prior to afforestation. Many of the water use figures reported in South Africa originate from sapflow measurements. These have been conducted on a single tree or a very small number of trees in a stand. It has been shown in other studies that single tree water use cannot be upscaled to reflect the stand-level water use as it introduces significant error. Due to the cost of equipment required to measure tree water usage, replication of treatments in past (and current) studies is also very limited.

1 *Gush MB and Dye PJ (eds). 2015. Water use and socio-economic benefit of the biomass of indigenous trees. WRC Report No. 1876/2/15. Pretoria: Water Research Commission.*
2 *Poore MED and Fries C. 1985. The ecological effects of Eucalyptus. FAO, Roma (Italia).*
3 *Scott DF and Prinsloo FW. 2008. Longer-term effects of pine and eucalypt plantations on streamflow. Water Resources Research 44(7).*

Fast facts

- Research results from various studies comparing water use of pines to that of eucalypts varies greatly and does not consistently show that one genus uses more water than the other.
- If comparisons are made over a time-span longer than 20 years, differences in water use between *Pinus* and *Eucalyptus* are not statistically significant.
- On economic WUE (levellised Net Present Value per m^3 of water), eucalypts tend to be the most water use efficient of all species (in comparison to pine and various indigenous plantations) on a per mass or volume of wood produced, basis.
- *Eucalyptus* roots grow as shallow as possible and as deep as necessary in response to the required water supply.

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Continued

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Measurement of water use efficiency (WUE) is normally linked to productivity or biomass measures such as stem volume production per unit water used. Expression of WUE in this manner - as annual stem volume increment per unit volume of water transpired for *Eucalyptus* species across age classes and site types in South Africa, ranges from 0.0008 to 0.0123 cubic metres (m^3) stem wood produced per m^3 water consumed[4]. There is, furthermore, variation in WUE between varieties (of the same age and on the same site), with a tendency for the fastest growing genotypes, to consume the least water per mass or volume of wood produced, therefore being more water efficient. Furthermore, from available measurements, on economic WUE (levellised Net Present Value per m^3 of water), eucalypts tend to be the most water use efficient of all species (in comparison to pine and various indigenous plantations) on a per mass or volume of wood produced, basis[5].

How deep can *Eucalyptus* tree roots penetrate the soil?

The maximum rooting depth value, reported in a scientific paper, is 60 m for a *Eucalyptus* species[6]. Although this value is often quoted in other scientific papers, the original publication does not supply any additional information on this species, or the location and age of this specific tree. In this same scientific report, the maximum depth for a *Eucalyptus marginata* tree, for which the source of information is provided, is indicated as 40 m, but this is the maximum rooting depth ever recorded. In Brazil, the relationship between above-ground and below-ground development of *Eucalyptus grandis* trees was studied on soils without any chemical or physical barriers. This research work showed that the fine root front depth was accurately predicted at 85% of mean tree height. Thus, it is unlikely that *Eucalyptus* tree roots will penetrate to depths greater than the tree height. As South Africa does not have very deeply weathered soils, rooting depth is mostly limited by solid rock layers.

Very little information exists on rooting characteristics as it is very difficult to study roots and deep roots in particular. The rooting studies that have been done were mostly conducted on sites where it is easier to do the work (deep sandy soils without rocks). Only 10% of rooting studies investigated roots at depths greater than one metre below the surface. One should also realise that the presence of roots or rooting depth should not be used as an indication of water use. It only indicates that the tree can potentially use that water. It is a misconception that trees only pump water in one direction i.e. from the subsoil to the surface. Tree roots can move water within different soil layers[7]. If water is redistributed from depth to dry topsoil it is called "hydraulic lift". However, tree roots can also transfer significant quantities of water downward to dry soil layers when surface soil layers become wet following rain, through the process of "hydraulic redistribution". The hydraulic lift required to raise large amounts of water is very energy intensive for trees. Roots located at depth will also incur a maintenance respiration cost to production. Thus, deep water uptake would be used as a short-term survival strategy rather than for continued growth. To summarise: roots grow as shallow as possible and as deep as necessary in response to the required water supply.

[4] *Albaugh JM, Dye PJ and King JS. 2013. Eucalyptus and water use in South Africa. International Journal of Forestry Research, http://dx.doi.org/10.1155/2013/852540.*

[5] *Dye PJ, Gush MB, Everson CS, Jarmain C, Clulow A, Mengistu M, Geldenhuys R, Wise R, Scholes RJ, Archibald S and Savage MJ. 2008. Water-use in relation to biomass of indigenous tree species in woodland, forest and / or plantation conditions. Report to the Water Research Commission. WRC Report No. TT 361/08.*

[6] *Stone EL and Kalisz PJ. 1991. On the maximum extent of tree roots. Forest Ecology and Management 46: 59-102.*

[7] *Maeght JL, Rewald B and Pierret A. 2013. How to study deep roots—and why it matters. Frontiers in Plant Science 4: 299.*

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